Journal of the Society of Arts.

FRIDAY, JANUARY 1, 1869.

Announcements by the Council.

FINAL EXAMINATIONS, 1869.

Notice to Institutions and Local Boards.

In order to avoid holding these Examinations on the same evenings as those of the Department of Science and Art, it has been decided to hold them, in 1869, on the evenings of

TUESDAY,	**the 20th**	**APRIL,**
WEDNESDAY,	**the 21st**	„
THURSDAY,	**the 22nd**	„
FRIDAY,	**the 23rd**	„

From 7 p.m. to 10 p.m., instead of on the 27th, 28th, 29th, and 30th April, as announced in the Programme of Examinations for 1869.

In consequence of this alteration the Previous Examinations must be held earlier, and the Forms No. 2 and No. 4, referred to in par. 6 of the Programme, must of course be sent in a week earlier than the dates there fixed for receiving them.

It is very important that this alteration should be made as public as possible. For this purpose a number of small slips, to be inserted between pages 8 and 9 of every Programme sent out, have been forwarded to each Institution and Local Board. They should also be specially sent to any person to whom Programmes may have already been forwarded.

Large bills, to be suspended on the walls of the Institution reading-room, or in some other public place, will also be provided.

Subscriptions.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. Samuel Thomas Davenport, Financial Officer.

Proceedings of the Society.

Food Committee.

The Committee met on Wednesday afternoon, 9th December. Present—Mr. Benj. Shaw (in the chair), Mr. G. F. Wilson, F.R.S., and Mr. Edward Wilson.

William Shand, Esq., of St. Cloud, attended to give information to the Committee relative to an invention for the preservation of meat, fish, &c., by means of refrigerated air.

Mr. Shand said—The object of my visit to-day is to bring under the notice of the Committee an invention with which I am connected, which it is proposed to apply to facilitating the supply of fish, more particularly, to the great markets of Europe. The principle on which this invention is based is that of the refrigeration of the atmosphere by artificial means, which I will describe hereafter. The invention is, I think, an important and interesting one as being decidedly applicable to the preservation of meat as well as fish; but as I believe that question is before the Committee in some other form, I will not enter upon it, but will confine myself chiefly to the question of fish. I may here mention that this matter did not present itself to my mind in the first instance with respect to the preservation either of meat or of fish. The refrigeration of the air presented itself to my mind in connection with steam navigation, particularly through tropical latitudes, where, as you are aware, steam navigation is carried on under great disadvantages to many persons who are employed in it, particularly the engineers and stokers, as well as the passengers and crews in general. The refrigeration of the atmosphere as well as the ventilation of ships under such circumstances, is, therefore, a matter of great importance. In the application of the invention to the purpose I have just mentioned, I have given it the title of "A Special Climate." We propose to refrigerate the atmosphere to any degree that may be required, by means of which vessels may navigate the tropics with a temperature of air in the cabins and sleeping apartments at once cool and refreshing to the occupants of them. But the particular question with respect to which this Committee, I apprehend, is chiefly interested, is that of facilitating an increased supply of fish to our markets. During my residence in France, I have observed that the fish market at Paris is very irregularly supplied. In the course of the investigations I made on this subject, I came to the conclusion that a very great advantage would be conferred not merely upon France, but upon the inhabitants of Europe generally, if we could apply this invention for the refrigeration of the air to the transport and preservation of fish. I find that in France all the fish, and in England the great bulk of it, is brought to market by railway, a very advantageous mode of carriage when you require great rapidity, but expensive. I found also that there was sometimes a great loss of fish in consequence of the difficulty and expense of transit, and the necessity for packing in ice for conveyance to market. It was stated in evidence before the British Parliamentary Commission, that in 1863 some of the fishing vessels threw away ten tons of haddocks per day in the North Sea, because they had not a sufficiency of ice, and the cost of ice was too great to make it worth while to bring them to the market. The supply of fish to Paris is sent entirely by railway. Water communication is not at present in a state to allow of fish reaching Paris in that way, but I propose to apply this invention to steamers on the Seine, so as to bring up fish at a cheap rate. I found there were certain other advantages to be gained in carrying out that idea, the principal of which was this—You have at the market on one day a large supply of fish, and on other days, when the weather is bad, there is little or no fish at all at market. In consequence of that state of things in Paris, and to a large extent in London also, I believe that the consumption of fish generally is very much reduced. Sometimes it is not to be had, whilst at others a larger quantity of fish than the market can take up is thrown upon it. There is often a great loss of fish, no doubt, through its getting bad at the time of such gluts, before it can be consumed by the population. On the other hand, when the supply is very scanty, the price runs up to such a figure that it can only be obtained by the wealthy classes. I therefore propose, in connection with my refrigerating apparatus, not merely to transport the fish from the localities where it is caught in steamers to which

this apparatus should be applied, and which could be brought up the Seine, the Thames, the Rhine, and other rivers, but also to form depôts at certain spots—as, for instance, on the quay of the Seine, close to the wholesale market in Paris, where I could retain my stocks of fish when I found that the supply was beyond the requirements of the market, and where I should be able to keep it until it could be sold to advantage. That I regard as a collateral advantage of the refrigeration as applied to the preservation of fish. It is applicable, as I have already stated, not only to fish, but to meat, butter, eggs, and many other articles of food, of which the supply in the markets is occasionally very large, and altogether beyond the requirements of the public, and at others is deficient. I go on to observe that I have studied the subject in another important aspect. The opinion is decidedly held in France, amongst those who have studied the question, that the coast fisheries are being exhausted. Perhaps I may be allowed (continued Mr. Shand) to make a few very short remarks upon the history of these sea fisheries. The sea fisheries of Europe took their earliest development in the Mediterranean, the Gulf of Lyons, and the sea coast around Marseilles—all once famous for their enormous wealth of fish. There has been a gradual decrease in the take of fish on these shores. Down to the present day the fish is continually decreasing; the population dependent on fishing for a living is decreasing; and, in point of fact, the fisheries are being exhausted. The same state of things may be distinctly predicated of many other parts of the coast. The report of the British Fisheries Commission shows that the fish upon our coast—the immediate shore of the country—are decreasing, so much so, that fish which were formerly caught by lines cannot now be so taken in any quantity, and the great bulk of fish is now taken by the trawl further at sea. The trawl fishers maintain that that system does not destroy the fish, but, on the contrary, more fish come after their nets, from their stirring up the bottom, and supplying them with more food. That may be the case; and as the Commissioners report, the necessity for the supply of fish is so great, they cannot stop trawl fishing, because there are no other means sufficiently efficacious of obtaining it. The effect of trawl fishing in the Mediterranean (which is the original seat of trawl fishing, where it has its own peculiar fashions) has been unquestionably to destroy the fishery along that coast, and the French authorities—not only scientific but practical men—are united in opinion that the fisheries are being worked out everywhere on the coast. The same causes which have operated in the Mediterranean equally apply to the North Sea. Seeing, then, there is this decided opinion on the part of the French authorities, that the existing fisheries are being exhausted, the invention I am speaking of will, I think, come in to facilitate the working of valuable fisheries at greater distances, from whence, without some such means as these, you could not possibly transport the fish in a fresh state. I will now, with the permission of the Committee, proceed to describe what this particular apparatus is we propose to apply for facilitating the transport and conservation of fish. It is just simply this—instead of employing ice, we have an apparatus for refrigerating the air. We reduce the temperature of the air down to about freezing point by a special apparatus, and we maintain the air at that particular point by the action of the apparatus, at the same time preventing as much as possible the infiltration of heat into the chamber refrigerated. It is proposed to apply this refrigerating apparatus to ships specially constructed for the transporting of fish. You enclose the space in which you wish to put the materials to be preserved by walls as impervious as possible to the infiltration of heat, and you may work your refrigerating machine either inside or outside this chamber, and by that means you constantly keep up a cool temperature in it. The fish may be laid in baskets, piled one above another, or in the case of meat the carcases may be hung up and they will remain good I cannot say how long. I may state that in Paris we have kept fresh fish for three weeks without deterioration. Legs and other joints of mutton have been hung from seven to nine weeks without the smallest appearance of decay, and after their removal from the chamber they have been kept for thirty-six hours in the air before being cooked without experiencing any deterioration whatever. Fish which had been kept for a fortnight was cooked at a restaurant in the Palais Royal with other fish bought at the day's market and there was no perceptible difference between the one and the other. The apparatus is in itself a very simple affair, consisting of a cylinder of cast-iron, very much resembling the boiler of a locomotive steam-engine, cast-iron answering the purpose, as the pressure is not very great. There are tubes running through the centre of the cylinder, similar to the smoke tubes of a locomotive engine. A pump is applied to it to exhaust the vapour of the volatile liquid which is placed inside the cylinder. M. Tellier, the inventor of this apparatus, places within his cylinder liquid ammonia, although, I believe, he gives the preference to methylic ether, of which, if he is not the discoverer, he claims to be the only person actually preparing it, but in consequence of the objection of insurance companies to the use of ether on board ship, he has employed ammonia instead. There are other liquids which can be used for the same purpose, provided they are volatile. The liquid placed within the cylinder passes naturally into a state of vapour. The action of the pump withdraws that vapour, as it is produced, on the one side, and condenses it—that is, applies pressure to it—on the other side, within certain pipes, which convey it, while it is under compression, through a worm, like that of a still, when it returns to the liquid state. As the ammonia, or other volatile substance, is restored to the liquid state, it passes back again to the cylinder, and not a drop of it is wasted. The same liquid is applied over and over again. The only power required is that necessary to work the pump, and a ventilator or fan to give motion to the air in course of refrigeration. M. Tellier's mode of application of the apparatus to the hold of a ship, or a room, or a cellar fitted for the purpose, is by means of two tubes, one passing the air into the chamber at the bottom, the other withdrawing the air at the top. Between the withdrawal and the return the air passes through the cylinder by means of the tubes. During its passage it parts with its heat to the ammonia within the cylinder, which absorbs it. The motive-power required is something very small, but dependent, of course, upon the quantity of air you want to refrigerate. All the power required is that which is sufficient to work the pumps, and to keep up the motion of the air through this chamber. These are the general features of the invention. By means of this arrangement I propose not only to bring large quantities of fish to Paris, but to distribute it into the interior of Europe. I consider we have in this invention not only the means of bringing fish from the coast of Africa, where there are the richest known fisheries in the world, but also of transporting it to South America, where it is largely consumed by the Roman Catholic populations, or to New York, or the West Indies, where fish is much in demand, and by this means a large field is opened for the supply of a very valuable article of consumption.

Mr. E. Wilson—Does this operation differ much in its mode of action from that employed in the manufacture of ice?

Mr. Shand—M. Tellier has an apparatus for producing ice. I was in Paris and wished to carry out my process, and M. Tellier was recommended to me as a person who was likely to facilitate my views. I found that in addition to machines for the production of ice he had also one for the refrigeration of water, as applicable to the cooling of the liquor in breweries. I believe one of these is in operation at Bass's Brewery, at Burton-on-Trent, by means of which the liquor is rapidly cooled to the required temperature.

The CHAIRMAN—Are you aware of the proposed Australian process of conveying meat inside cylinders, and reducing the temperature by the evaporation of ammonia?

Mr. SHAND—I have heard of it within the last few days; but I understood the plan there was to freeze the meat.

The CHAIRMAN—They propose to reduce the temperature artificially to the freezing point, free from contact with ice.

Mr. SHAND—I have received a communication from M. Tellier, in which he gives the price of his apparatus. He informs me that for a machine to cool 200 cubic metres of air per hour he charges the price of 3,500frs., and for 400 cubic metres per hour 4,500frs. I have understood from M. Tellier that he considers you should have a machine of sufficient force to cool the air every hour—that is, whatever space you require to cool you should have force sufficient to reduce the temperature of all the air within that space once every hour from that of the surrounding atmosphere to the degree of cold required. The price of the apparatus for 8,000 cubic metres per hour is 27,000 frs. The mechanical power required for the first size, or 200 cubic metres, is half-horse power, and so on up to 12-horse power for the largest size machine. The only expense of conducting the operation is the wages of the men in attendance, coal, and the repairs of the machine. The ammonia is used over and over again, requiring no renewal, so that the cost of that is a bagatelle. I may state that M. Tellier has already fitted up an apparatus for a vessel intended to navigate the Amazon River in connection with the transport of fish.

The CHAIRMAN—Can you reduce the temperature to the freezing point by means of this apparatus?

Mr. SHAND—I have no doubt we can reduce it much lower than that. The temperature is proposed to be kept about freezing point, but M. Tellier has assured me he can get a much lower degree of temperature than freezing point. If it were desirable to freeze the meat it is quite possible to do so by these means; but seeing that the freezing of meat is detrimental to it, we have not gone to that extent of refrigeration. We do not desire to go beyond the point necessary for perfect conservation. The experiments of M. Tellier with fish, &c., extended over two months. I believe a vessel is at present being fitted with the apparatus for bringing meat from Monte Video to London.

The CHAIRMAN suggested that members of the Committee would be glad to have an opportunity of inspecting it, and

Mr. SHAND replied, he should be happy to introduce them to M. Tellier's agent in London. He expressed an opinion highly favourable to the success of this process in the bringing of meat from long distances.

In reply to a question by Mr. E. WILSON, as to the probable cost of fitting up spaces for the application of the refrigerating process,

Mr. SHAND stated—I wrote to M. Tellier for information on that subject, and as he has not enjoined me to secrecy, I will state what the purport of it is. I inquired of him whether there were any peculiar arrangements with regard to the isolation of the chamber, in reply to which he informs me, that in fitting up the forecastle of a ship for the purpose of this process, he introduced a layer of melted resin between the planks forming the chamber in which the articles are to be deposited, and the chamber would be completely closed, except the hatches, which gave access to it. Why he employs the layer of resin I do not know, except as an excess of caution. In America, in the carriage of meat by railway, it is isolated by charcoal in zinc receptacles. A box of ice placed in the railway van to cool the air would, I imagine, be sufficient for a few hours' journey of meat, &c. M. Tellier, as I have already stated, has machines for the production of ice which he can manufacture at something like 8s. per ton. M. Carré restores the vaporised ammonia to a liquid state by availing himself of its affinity for water, and, consequently, he has to go to greater expense to recover the ammonia to be used again. Tellier uses the ammonia perfectly pure, and water is not used to recover its vapour. I observe that there are several patents for refrigerating processes. One of them is Harrison's patent, to which Tellier's appears to me to bear some resemblance.

The CHAIRMAN, on behalf of the Committee, thanked Mr. Shand for his attendance, and for the interesting information he had given them, and the Committee adjourned.

CANTOR LECTURES.

"ON THE ANILINE OR COAL TAR COLOURS."

BY W. H. PERKIN, ESQ., F.R.S.

LECTURE I., DELIVERED MONDAY, DECEMBER 7TH.

Coal Tar, Benzol, Nitrobenzol, Aniline, and Aniline Purple or Mauve.

In this short course of lectures it is my desire to bring before you a somewhat condensed history of the artificial colouring matters, generally known as the "Coal Tar Colours." By this designation it is not meant to imply that colouring matters actually exist in coal tar, and may, therefore, be extracted from it, but that coal tar is the source of certain products which, when changed by various chemical processes, are capable of yielding coloured derivatives. You will thus perceive that it is important for us to consider the various means employed to obtain the raw materials before giving our attention to the colouring matters themselves. We will, therefore, at once proceed to the consideration of "coal tar;" its formation and constitution.

Coal tar consists of the oily fluid formed by the destructive distillation of coal, and is obtained as a secondary product in the manufacture of coal gas. Originally, coal tar was a great nuisance to the gas manufacturer, and it was often a problem to him what he should do with it. I need scarcely say that this state of things is now changed. In the gas works the coal is distilled in large retorts, sometimes 25 or 30 feet in length. They are made of fire-clay or iron, and several are arranged in one furnace, or oven, as it is usually termed. Each retort is fitted with an iron mouth-piece, from which a vertical tube rises, the mouth-piece also having a door fastened with a cross-bar and screw.

When in use these retorts are rapidly filled with coal by means of a proper scoop, and then the doors luted and fixed so as to be air-tight. Distillation commences immediately, as the retorts are constantly kept red hot. The gas and other products which form pass up the front vertical pipe (connected with the mouth piece), through a bend, and down into a long horizontal tube, called the "hydraulic main." Here most of the oily products condense, and as they accumulate pass on with the gas down the general main, and flow into a tank provided for their reception. These oily products constitute "coal tar." The coal gas, leaving this tar behind, passes on to the condensers, and deposits a second but smaller quantity of tar, and is then purified and stored in the gas holders. The gas, however, does not interest us now.

I am here distilling some coal in a small glass retort, the beak of which is inserted into one of the openings of a three-necked receiver. The second opening is connected with the tube, so that the gaseous products may be examined, whilst the third and lower one is fitted to a small bottle, in which you see we have already obtained a quantity of an oily fluid. This is our coal tar.

Having now seen how coal tar is produced, we will consider of what it consists. Coal tar is by no means a definite body, but contains a great number of different substances, as a glance at the following table will show:—

TABLE I.—PRODUCTS OF THE DISTILLATION OF COAL.

Name.	Formula.	Boiling point. Centigr.
Hydrogen	$H H$	..
Marsh gas (hydride of methyl)	$(C H_3)H$	..
Hydride of hexyl	$(C_6H_{13})H$	65
Hydride of octyl	$(C_8H_{17})H$	106
Hydride of decyl	$(C_{10}H_{21})H$	158
Olefiant gas (ethylene)	C_2H_4	..
Propylene (tritylene)	C_3H_6	..
Caproylene (hexylene)	C_6H_{12}	55
Œnanthylene (heptylene)	C_7H_{14}	99
Paraffin	$C_n H_n$	..
Acetylene	C_2H_2	..
Benzol	C_6H_6	80·8
Parabenzol	C_6H_6	97·5
Toluol	C_7H_8	110
Xylol	C_8H_{10}	139
Cumol	C_9H_{12}	148·4
Cymol	$C_{10}H_{14}$	170·7
Naphthalene	$C_{10}H_8$	212
Paranaphthalene (anthracene)	$C_{14}H_{10}$	..
Chrysen	C_6H_4	..
Pyren	$C_{15}H_4$	..
Water	$\left\{\begin{matrix}H\\H\end{matrix}\right\}O$	100
Hydrosulphuric acid	$\left\{\begin{matrix}H\\H\end{matrix}\right\}S$	..
Hydrosulphocyanic acid	$\left\{\begin{matrix}H\\(CN)\end{matrix}\right\}S$	..
Carbonic oxide	$C O$	..
Carbonic anhydride	$C O_2$	..
Bisulphide of carbon	$C S_2$	47
Sulphurous anhydride	$S O_2$	—10
Acetic acid	$\left\{\begin{matrix}H\\(C_2H_3O)\end{matrix}\right\}O$	120
Carbolic acid (phenol)	$\left\{\begin{matrix}H\\(C_6H_5)\end{matrix}\right\}O$	188
Cresylic alcohol (cresol)	$\left\{\begin{matrix}H\\(C_7H_7)\end{matrix}\right\}O$	203
Phlorylic alcohol (phlorol)	$\left\{\begin{matrix}H\\(C_8H_9)\end{matrix}\right\}O$	..
Rosolic acid	$C_{12}H_{12}O_3$	..
Brunolic acid	..	..
Ammonia	$\left\{\begin{matrix}H\\H\\H\end{matrix}\right\}N$	—33
Aniline	$\left\{\begin{matrix}(C_6H_5)\\H\\H\end{matrix}\right\}N$	182
Pyridine	$(C_5H_5)'''N$	115
Picoline	$(C_6H_7)'''N$	134
Lutidine	$(C_7H_9)'''N$	154
Collidine	$(C_8H_{11})'''N$	170
Parvoline	$(C_9H_{13})'''N$	188
Coridine	$(C_{10}H_{15})'''N$	211
Rubidine	$(C_{11}H_{17})'''N$	230
Viridine	$(C_{12}H_{19})'''N$	251
Leucoline	$(C_9H_7)'''N$	235
Lepidine	$(C_{10}H_9)'''N$	260
Cryptidine	$(C_{11}H_{11})'''N$	256
Pyrrol	$(C_4H_5)'''N$	133
Hydrocyanic acid	$H C N$	26·5

This list, however, does not indicate all the constituents of coal tar, but only those which chemists have up to the present time succeeded in separating from it; moreover, when we consider how greatly coal differs in composition, and also that the products vary according to the temperature to which the coal has been submitted, it is evident that coal tar must be an almost endless source of chemical products. Many would perhaps consider this list a perfectly hopeless jumble of names impossible to impress upon the memory; but, fortunately, chemists are able to classify their products, so that this formidable array of substances may be grouped under three or four different heads only, and, therefore, their relationship being once understood, little difficulty is experienced in remembering their names.

Amongst these products, and at the lower part of this table, you will observe a substance called "aniline." This substance is of great interest to us, being one of the principal sources of the coal-tar colours. Aniline was discovered by Unverdorben, in 1826, amongst the products of the distillation of indigo, and from its property of forming crystalline compounds with acids was called "crystalline." Afterwards Runge obtained it from the distillation of coal, and, because it gave a blue colouration with a solution of chloride of lime, called it "kyanol" or blue oil. Fritzsche, still later, obtained aniline by the distillation of indigo with hydrate of potassium, and gave it its present name, derived from anil, the Portuguese for indigo. About this time Zinin discovered a remarkable reaction, by which he obtained aniline from a substance called nitrobenzol; he called it, however, benzidam. The products obtained by these different chemists were not at first known to be identical; and it was not until Dr. Hofmann investigated the subject that they were all shown to be the same body, aniline.

Zinin's process for the conversion of nitrobenzol into aniline consisted in treating the nitrobenzol with an alcoholic solution of sulphide of ammonium; this was greatly improved upon by Bechamp, who employed a mixture of finely-divided iron and acetic acid, in place of sulphide of ammonium.

This is a brief sketch of the history of aniline up to the time of the discovery of the mauve dye; it was then purely a laboratory product, and was prepared in very small quantities at the time, and only when required for scientific research. Chemists have always been desirous of producing natural organic bodies artificially, and have in many instances been successful. It was while trying to solve one of these questions that I discovered the "mauve." I was endeavouring to convert an artificial base into the natural alcaloid quinine, but my experiment, instead of yielding the colourless quinine, gave a reddish powder. With a desire to understand this peculiar result, a different base of more simple construction was selected, viz., aniline, and in this case I obtained a perfectly black product; this was purified and dried, and when digested with spirits of wine gave the mauve dye.

You will perceive that this discovery did not in any way originate from a desire to produce a colouring matter, as is sometimes stated, but in experiments of a purely theoretical nature.

After showing this colouring matter to several friends, I was advised to consider the possibility of manufacturing it upon the large scale, and was, eventually, induced to make the experiment, though, I must confess, not without considerable fear of the result, especially as my chemical advisers set before me anything but encouraging prospects. In starting this manufacture, the first difficulty was to decide upon the source from which aniline could be obtained at a sufficiently low price. It was at once evident that indigo was by far too costly a product for this purpose. Attention was therefore directed to the extraction of aniline from coal-tar, but after very numerous experiments, it was found that the difficulty of purifying it was so great, that it was not practicable to prepare it at a reasonable price from this product. There was, therefore, but one source left, namely, nitrobenzol; but to prepare aniline from this body necessitated the establishment of a new manufacture; nitrobenzol at that time not being a commercial article, and although it could be produced in small quantities without much difficulty, yet when tons were required at a limited cost many obstacles presented themselves.

Having spoken of nitrobenzol, it will be necessary, before proceeding further, to tell you something of the body it is prepared from, and also how it is made in quantity. Nitrobenzol is produced from a derivative

of coal-tar called benzol—you will see it mentioned in the list of coal-tar products. It is composed exclusively of carbon and hydrogen, and is therefore called a hydrocarbon.

Benzol was discovered by Faraday, in 1825, one year before aniline by Unverdorben. Its existence in coal-tar was first pointed out by Dr. Hofmann, in 1845 and afterwards Mansfield showed that an almost unlimited supply might be obtained from this source. Benzol is a volatile oil, boiling at a temperature of 80·8° C., nearly twenty degrees lower than water, and is also very inflammable, burning with a smoky flame. When ignited it cannot be extinguished by water, as it floats upon its surface. Its vapour, when mixed with air, is explosive. It is also very dense. This I can easily show you by decanting a small quantity of benzol vapour several times from one vessel into another, and then igniting it. Instances have been known, when distilling benzol in large quantities, and some leak in the apparatus has occurred, so that its vapour has escaped, that it has run along the ground, and been ignited by a furnace situated thirty or forty feet distant, and instantly run back to the apparatus. To illustrate this I will pour some benzol vapour into the top of a slightly inclined trough, fourteen feet long, at the lower end of which is placed a lamp. The vapour will be seen to run gradually down till it reaches the lamp, where it ignites and instantly rushes back to the top of the trough. One of the most remarkable properties of benzol is, that when cooled down to nearly the freezing point of water, it solidifies to a beautiful crystalline mass. This property of benzol is sometimes taken advantage of when it is required in a very pure state, as the impurities which accompany it are fluid, and do not freeze when cooled with ice.

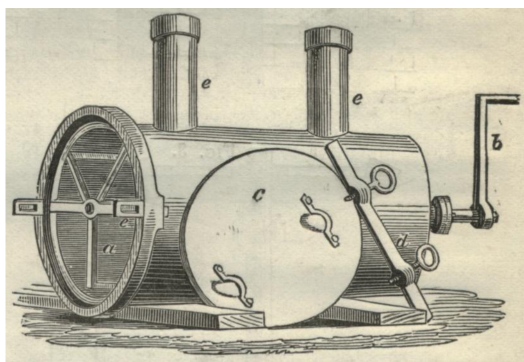
Benzol is often sold under the name of benzine collas, for the purpose of removing grease from wearing apparel. But let us consider how benzol is separated from the great number of products with which it is associated in coal-tar. The first operation consists in distilling the coal-tar, just as it comes from the gas-works, in large stills, holding one or two thousand gallons each; these are often made of old steam-boilers; at first very volatile and light oily products come over, and are collected until their density increases to such an extent that they no longer float upon water. These constitute crude coal-tar naphtha. The distillation is then carried on, and heavy, or, as they are technically termed, "dead" oils, are collected, a residue of common pitch being left in the still. This pitch is generally run out, and cast into blocks; but sometimes the distillation is carried on after the dead oils have been obtained, when a mixture of solid oily products distils, nothing but a kind of cake being left behind. These latter substances, however, do not interest us now.

The light oil, or crude coal tar naphtha, is then purified by one or two alternate distillations with steam and treatments with concentrated sulphuric acid. It is thus rendered a colourless fluid. Thus purified, coal tar naphtha contains, besides benzol, at least four or five other bodies. These, however, mostly differ from benzol in being less volatile; therefore, the naphtha is again distilled, the first, or more volatile, portions only being collected for benzol. By repeating this process of fractional distillation several times commercial benzol is obtained. Some manufacturers employ stills of a peculiar construction, which enables them to obtain a good product by a smaller number of distillations. Benzol, when treated with fuming nitric acid or aquafortis, undergoes a remarkable change. At first the two fluids mix and become of a dark brown colour and slightly warm, in the course of a few moments red fumes appear, and the mixture enters into ebullition. During this violent action the colour of the liquid becomes lighter and ultimately changes to orange. If water be now added to this product, the benzol, which is such a light body, will be seen to have completely changed into a dense yellow oil sinking in water. This oil is nitrobenzol. Nitrobenzol was discovered in 1834, by Mitscherlich. It solidifies into a crystalline mass at a temperature of about 3° C.; its odour is like that of the oil of bitter almonds, and before the introduction of coal tar colours it was made in small quantities, and sold under the name of essence de Myrbane, for the purpose of scenting soap.

From the energy with which benzol is attacked by fuming nitric acid, nitrobenzol at first appeared to be a most difficult product to manufacture on the large scale, and this difficulty seemed the greater when it was found necessary that it should be made at a moderate cost. Moreover, at the time I am now referring to, fuming nitric acid, sp. gr. 1.5, could not be obtained in the market, or only at such a cost as almost to preclude its use. Under these circumstances, two mixtures were experimented with instead of the nitric acid in a very concentrated condition. The first was a mixture of nitrate of sodium and sulphuric acid, the second a mixture of ordinary nitric acid, sp. gr. 1.3, and sulphuric acid. The mixture of sulphuric acid and nitrate of sodium was preferred, and employed on the large scale.

The first apparatus used in the manufacture of nitrobenzol, for the preparation of aniline for the mauve dye, is shown in Fig. 1. It consisted of a large cast-iron

FIG. 1.



cylinder, *a*, fitted with a stirrer, *b*, and closed with a door, *c*, fastened by a cross-bar and screw, *d*. This cylinder was capable of holding between thirty and forty gallons. It was provided with two necks, *e e*, one for the introduction of the benzol and sulphuric acid, which were supplied through a syphon tube; the other for the exit of nitrous fumes. This last was connected with an earthenware worm, to condense any benzol which might be volatilised by the heat of the re-action. The nitrate of sodium was always introduced into the cylinder before the door was fastened up and luted. Until the preparation of nitrobenzol was understood, there was a great amount of uncertainty in its manufacture, and several explosions occurred, but fortunately without causing any injury to the workmen attending the apparatus. These explosions originated generally from the liberation of too much nitric acid from the nitrate of sodium, by the sulphuric acid, before the formation of nitrobenzol had begun, so that when it started, the chemical action set in with such energy that an explosion ensued. After a few of these unpleasant occurrences, however, sufficient experience was obtained to get the manufacture under control. Apparatus of a much more extensive character has since been substituted for the cylinders. In Figs. 2 and 3 you get a view of the apparatus now used in England for the manufacture of nitrobenzol.

This apparatus consists of large cast-iron pots, *a a a*, about 4 feet 6 inches deep, and 4 feet 6 inches wide; they are arranged in rows, and provided with stirrers, worked from a shafting by means of bevel wheels. This arrangement will be seen from the section, fig. 3; the covers of

Fig. 2.

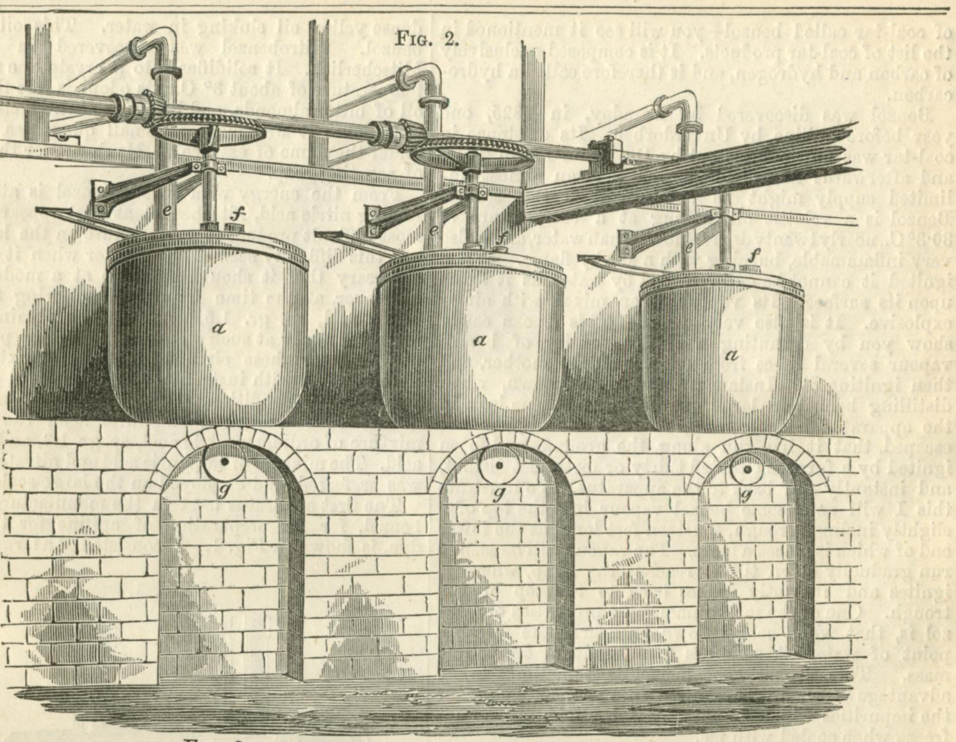
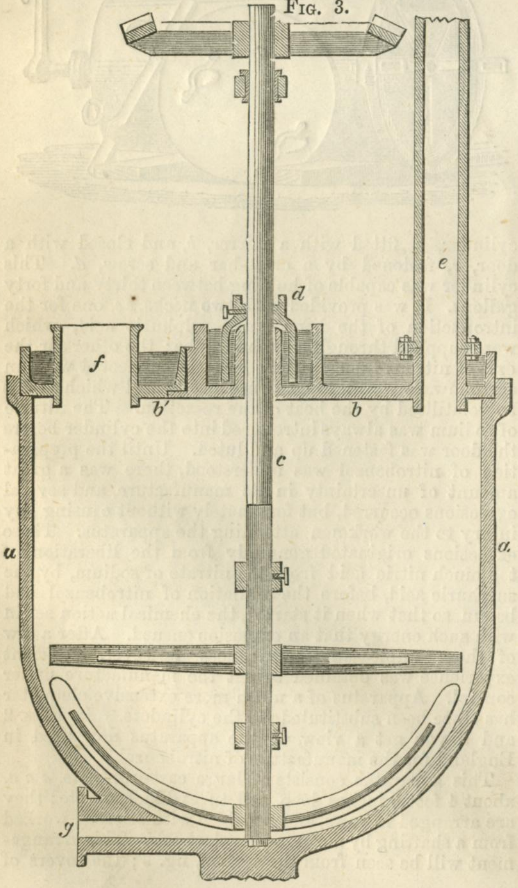


Fig. 3.



these vessels are also made of cast-iron, and are in two pieces *b b′* (Fig. 3) of unequal size, provided with a tall rim, and so arranged that cold water may be kept circulating over their surface; this assists in condensing the benzol, which would otherwise distil away by the heat of the reaction. Through the larger half of the cover the spindle of the stirrer, *c*, passes, and on account of the difficulty of keeping a stuffing-box in order when using the powerful chemicals necessary in this manufacture, a kind of water-joint has been substituted. It is necessary that it should be deep and rather capacious, as seen at *d*. Instead of filling this joint with water, which would absorb the nitrous fumes, and produce an acid solution, which would soon destroy the apparatus, the joint is filled with nitrobenzol; a cast-iron tube, *e*, passes through the lid to carry nitrous fumes; this is also cooled, so as to condense any benzol vapour which may have escaped the cooling action of the lid; small pipes are introduced through another opening for the purpose of supplying the necessary chemicals. Besides these, there is a large opening, *f*, in the smaller half of the lid, for the purpose of introducing any of the products, which may be added in large quantities at a time. At the bottom of these large vessels are openings for running out the finished product.

The process of preparing nitrobenzol with a mixture of sulphuric acid and nitrate of sodium in place of nitric acid, may be carried on very well in this apparatus, provided sufficient sulphuric acid be employed to produce an acid sulphate of sodium, as this will be found quite fluid at the close of the operation, and can be freely run out at the small outlet. A mixture of strong nitric acid and sulphuric acid is now usually employed for the conversion of benzol into nitrobenzol. In working by this latter method the entire charge of benzol is first introduced though the large opening in the lid; this is then closed and the stirrer set moving; the nitric and sulphuric acids are then cautiously run in through the small pipes, care being taken not to add too much nitric acid, until the red fumes begin to appear. After all the charge of acids has been added, and the reaction has

perfectly ceased, the product is drawn off. At first a mixture of sulphuric and nitric acids runs out, and then the nitrobenzol; this is collected separately and purified, first by agitation with water, and then rendered perfectly neutral by means of a dilute solution of soda. Should it contain any unconverted benzol this may be distilled off by means of steam. On the Continent manufacturers do not appear to have succeeded well in manufacturing nitrobenzol; when it first became a commercial article, their difficulty appears to have arisen from the fact that they experimented in earthenware vessels, which are both dangerous and unsuitable, and it was not until information was obtained from England, I believe, that they were able to produce this body at a moderate price.

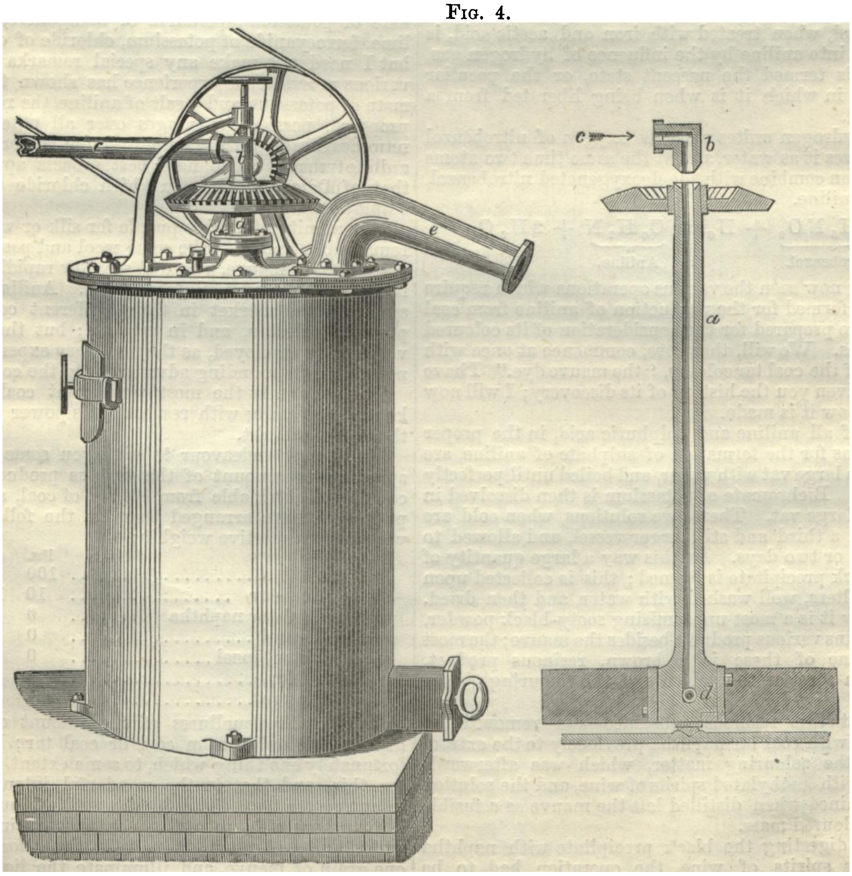
We will now pass on to the processes for converting nitrobenzol into aniline. I have already mentioned that Zinin was the first who discovered that nitrobenzol could be converted into aniline, or, as he termed it, benzidam. His process consisted in treating an alcoholic solution of nitrobenzol with ammonia and sulphuretted hydrogen; but, although the discovery of this process was one of great importance from many points of view, still it was very tedious. Bechamp, however, found that by employing a mixture of acetic acid and finely divided iron instead of ammonia and sulphuretted hydrogen, the nitrobenzol was very rapidly converted into aniline, and this process has been found the best yet proposed for manufacturing aniline in large quantities. Many other reagents have been suggested, as arsenite of sodium, powdered zinc, &c., but none of them have been found so advantageous as iron and acetic acid.

In carrying out Bechamp's process, cylinders like those used for nitrobenzol (Fig. 1) were originally employed. The cylinder was set in brickwork, and heated by means of a small furnace, iron borings were first introduced, and the door fixed in its place air-tight. One neck was connected to the upper extremity of a cast-iron worm by means of a pipe called an adapter; the second neck being fitted with a syphon-tube, for the introduction of the nitrobenzol and acetic acid. In working on the large scale it is necessary to add the nitrobenzol and acetic acid in small quantities at a time, otherwise the reaction is so violent as to almost burst the apparatus: by working carefully, however, there is no need to fear any difficulties, especially if the stirrer is well used. By the time all the charge has been introduced, a quantity of fluid will have distilled over; this is returned into the cylinder and the fire lit, and the aniline distilled off.

The principal change which has taken place in this process consists in using high pressure or superheated steam for the distillation instead of fire, and working the apparatus by means of a steam-engine instead of by hand. In Fig. 4 is shown a sketch of the apparatus now generally employed for the preparation of aniline.

You will observe that the stirrer, which is worked by bevel wheels, has a hollow shaft or spindle, *a*, as seen in the section. This is ground to an elbow, *b*, connected to the steam main, *c*, and held down by a screw, so that when the steam is turned on, it passes through the hollow elbow down the shaft, and then blows out at the bottom, *d*, among the products; and in this manner the aniline is volatilized, and passes with the steam through the neck, *e*, and is condensed by a worm, not shown in this drawing. Aniline thus obtained is generally redistilled,

FIG. 4.



and sometimes with a little lime or caustic soda, for the purpose of decomposing a body called acetanilide, which is often produced in the manufacture of aniline, especially if the operation is conducted over a fire instead of with steam.

Commercial aniline generally appears of a pale sherry colour; when chemically pure, it is colourless, but if kept long it becomes quite brown. It possesses a peculiar odour, which is slightly vinous when the aniline is pure. It burns with a smoky flame, but is not very inflammable; its boiling point is 182° C. One of its most characteristic re-actions is its power of producing a blue or blue violet colouration with chloride of lime, to which I shall again have occasion to refer. Aniline differs entirely from benzol and nitrobenzol, being perfectly soluble in dilute acids. This is owing to its being an organic base, and forming compounds with acids. Thus with hydrochloric acid, it forms hydrochlorate of aniline; with sulphuric acid, sulphate of aniline, &c.

We will now, in a very rapid and general way, glance at the chemical changes which take place in connecting benzol with nitrobenzol and aniline.

Benzol, as I have already stated, is a hydrocarbon, *i.e.*, a body composed of hydrogen and carbon only; it is represented by

$$C_6 H_6$$

This is treated with nitric acid, which contains

$$H N O_3$$

The nitric acid acts upon the benzol and introduces its nitrogen and part of its oxygen, at the same time removing hydrogen and forming water.

$$\underbrace{H N O_3}_{\text{Nitric acid.}} + \underbrace{C_6 H_6}_{\text{Benzol.}} = \underbrace{C_6 H_5 N O_2}_{\text{Nitrobenzol.}} + \underbrace{H_2 O}_{\text{Water.}}$$

Nitrobenzol, when treated with iron and acetic acid, is converted into aniline by the influence of hydrogen gas, in what is termed the nascent state, or the peculiar condition in which it is when being liberated from a compound.

This hydrogen unites with the oxygen of nitrobenzol and removes it as water, and at the same time two atoms of hydrogen combine with the deoxygenated nitrobenzol, forming aniline.

$$\underbrace{C_6 H_5 N O_2}_{\text{Nitrobenzol.}} + H_6 = \underbrace{C_6 H_7 N}_{\text{Aniline.}} + 2 H_2 O$$

Having now seen the various operations which require to be performed for the production of aniline from coal tar, we are prepared for the consideration of its coloured derivatives. We will, therefore, commence at once with the first of the coal tar colours, "the mauve dye." I have already given you the history of its discovery; I will now tell you how it is made.

First of all aniline and sulphuric acid, in the proper proportions for the formation of sulphate of aniline, are mixed in a large vat with water, and boiled until perfectly dissolved. Bichromate of potassium is then dissolved in a second large vat. These two solutions, when cold, are mixed in a third and still larger vessel, and allowed to stand one or two days. In this way a large quantity of a fine black precipitate is formed; this is collected upon shallow filters, well washed with water, and then dried. When dry it is a most unpromising sooty-black powder, and contains various products besides the mauve; the most troublesome of these is a brown, resinous product, soluble in most of the solvents of the colouring matter itself.

At first this resinous substance was removed by digestion with coal tar naphtha previously to the extraction of the colouring matter, which was afterwards effected with methylated spirits of wine, and the solution thus obtained when distilled left the mauve as a fusible bronze-coloured mass.

When digesting the black precipitate with naphtha or strong spirits of wine, the operation had to be performed in closed vessels under pressure or in connection with a condensing arrangement, otherwise large quantities of these valuable solvents would have been lost, and great difficulty was experienced in getting apparatus perfectly tight, on account of the "searching" character of these fluids. Substitutes had also to be found for the ordinary materials employed by engineers for making good manhole joints, and a number of other matters which are apparently of but small importance, but it is remarkable the amount of difficulty and annoyance they caused. The method of extraction has, however, been materially improved upon by substituting dilute methylated spirits of wine for strong, as this weaker spirit dissolves only a small quantity of resinous matter but all the colouring matter, so that the digestion with coal tar naphtha is now found unnecessary.

The solution of the colouring matter in dilute spirit is placed in a still and the spirit distilled off, the colouring matter remaining behind in aqueous solution; this is filtered and then precipitated with caustic soda. It is afterwards collected on a filter, washed with water, and drained until of a thick pasty consistence, and, if necessary, dried.

The solid mauve dissolves very freely in spirits of wine, forming an intensely coloured solution; it is also soluble to a small extent in water, but the aqueous solution on cooling forms a kind of jelly.

The formation of the mauve or aniline purple by the action of bichromate of potassium upon sulphate of aniline is a process of oxidation, and since the publication of the original specification at the Patent Office a great number of patents have been taken out for the preparation of this colouring matter, in which the bichromate has been replaced by other oxidizing agents, as peroxide of lead, permanganate of potassium, peroxide of manganese, chloride of lime, ferrocyanide of potassium, chloride of copper, &c.; but I need not make any special remarks upon these various processes, as experience has shown that bichromate of potassium and a salt of aniline, the reagents first proposed, possess advantages over all others, and are now nearly universally employed for the preparation of aniline purple. The next best process appears to be that of Dale and Caro, in which chloride of copper is employed.

The affinity of aniline purple for silk or wool is very remarkable, and if I take some wool and pass it through a solution of mauve, you will see how rapidly it absorbs it, even from a very dilute solution. Aniline purple is sent into the market in three different conditions, in paste, in solution, and in crystals; but the latter are very rarely employed, as they are very expensive and do not offer corresponding advantages to the consumer.

The mauve is the most permanent coal-tar purple known, especially with respect to its power of resisting the action of light.

I will now endeavour to give you some idea of the approximate amount of the various products we have considered obtainable from 100lbs. of coal, and for this purpose I have arranged them in the following table with their respective weights:—

	lbs.	ozs.
Coal	100	0
Coal-tar	10	12
Coal-tar naphtha	0	$8\frac{1}{2}$
Benzol	0	$2\frac{3}{4}$
Nitrobenzol	0	$4\frac{1}{4}$
Aniline	0	$2\frac{1}{4}$
Mauve	0	$0\frac{1}{4}$

You see the smallness of the amount of colouring matter obtainable from coal or coal tar; but there is fortunately one thing which, to some extent, compensates for this, and that is the wonderful intensity of this colouring matter. I will illustrate this remarkable fact. I have here a large carboy containing nine gallons of water, and will now add to this a solution containing one grain of mauve, and illuminate the liquid with the

magnesium lamp, and you see the single grain has coloured this large bulk of water. A gallon of water contains 70,000 grains, therefore nine gallons contain 630,000 grains. This solution, then, contains only one part of mauve to 630,000 of water.

I have now shown you the manifold operations which have to be performed before we can derive the mauve from coal tar, and have also mentioned a few of the obstacles which had to be overcome before its manufacture on the large scale could be accomplished. We have thus laid the ground work of our subject, and in our next lecture I hope to tell you a little more about mauve, and then give an account of the many other colouring matters of which it may be considered the parent.

Proceedings of Institutions.

City of London College Evening Classes.—The meeting for distribution of prizes and certificates gained at the annual examinations of the College, the Society of Arts, and the Government Department of Science and Art, was held at eight o'clock on Monday, December 7th. Mr. Alderman and Sheriff Cotton distributed the prizes. The Rev. Charles Mackenzie moved a vote of thanks to the Society of Arts, for the liberal encouragement received at their hands. Mr. Edward Clarke, barrister-at-law, seconded the motion. Votes of thanks were moved to the honorary examiners, to the College, and to the Rev. the Principal. A vote of thanks to Mr. Alderman and Sheriff Cotton, for presiding, brought the proceedings to a close.

THE MEYRICK COLLECTION OF ARMS AND ARMOUR.

(*Continued from page* 92.)

The targets in the upright black glazed case, placed at the commencement of the space allotted to the reign of Queen Elizabeth, are wonderful pieces of work. The two lower ones are of leather, and the two above them are of metal. It is much to be regretted that the former possessor of the collection, anxious to preserve these fine art-works from the bad effects of rust or damp, employed varnish, with which the targets have been thickly coated, greatly to the detriment of the engraved work. The target edged with silver and silk fringe belonged to Charles V., and is of Italian work, 1550, A.D. The surface is covered with numerous representations, consisting of the signs of the zodiac, illustrations of events in the Bible, classical and mythological subjects, and historical incidents of the reign of Charles V. The other, a steel target, is in low relief, probably from a design of Giulio Romano or Primaticcio, the subject of the design being the retreat of the British army under the Duke of Suffolk, 1523. Before quitting this case notice should be given to the aperture in one of the embossed leather targets, made to permit light from a lamp to be thrown upon an attacking foe. Three mounted figures in the bay devoted to the reigns of Edward VI. and Philip and Mary, are the most prominent objects. The first one is peculiarly interesting for the simplicity and almost ungraceful appearance of the various parts of the suit. The very high martonière is striking; but this form appears to have been the one adopted at this time, as other helmets and martonières at the back of this bay show. The brass fittings to the horse's bit and stirrups are unusual. The second figure is in a suit of armour known at the period as a suit of "Splints." It is of bright steel, studded with nails, and indentated. A most gorgeous suit is the last one of these three figures. Groupings of musical instruments, arms, human figures, and other devices, interlaced with arabesques, render the decoration of this suit most rich and refined. The work is Italian, 1560. It may be here interesting to remark the transition from the round knob at the butt of pistols at this period to the pear-like form given to them about the time of Charles I. The trophy of pistols in this, the 4th bay, contains many examples of the round form of butt. On the walls are fixed halbards, glaives, &c., which, unlike the ancient "spetums" and "morning stars," were chiefly for use on state occasions, pageants, &c. The pikes and poleaxes placed in the stand of halbards, &c., show one of the kinds of portable weapons employed in Edward VI.'s reign. A very noticeable, but unfortunately incomplete, set of engraved and damascened steel armour, mounted on a red board, is exhibited against the wall. The gauntlet belonging to this set is said to be of immense value, chiefly on account of its rarity in size and form. There are many excellent examples of Italian repoussée work placed on the wall, particularly a breast plate and champfront. Attention should be given to the beautiful engraved suit of Nuremburg work in this bay, and in fact to the numerous excellent specimens of engraving which abound almost throughout the whole of the collection.

At the head of the division, between the fourth and fifth bays, is a case containing some exquisitely-carved hunting "prodds," below which is a series of fine Italian high-combed morians. The two on the right are splendid examples of the repoussée and damascened arts. Probably the principal feature of the portable arms belonging to Elizabeth's reign is the rapiers and rich ornamentally-pierced hilts which prevail in all the arrangements of arms on the wall. Of shooting arms there is a handsome ivory cross-bow, with the original red silk tufts attached, a good sprinkling of hunting prodds; at one end of the bay an awkward-looking gun, weighing upwards of 20lbs., and at the other a "dag," with the barrel totally disproportionate to the butt—at least according to modern ideas of muskets. The halbards of this period are finely engraved "Military forks" were introduced about this time, and there are a few examples of them in the stand of bills and pikes. The lasting properties of leather are exemplified in the bay, by the one or two original sword-hangers, still in good preservation; these portions of military equipment are rarely to be met with. The present ones, in addition to their artistic interest for the connoisseur of stamped leather, have an attraction for the *curioso* as well. The morians, some with high combs and helmets, of this period are excellent. In a flat glass case, at the back of the bay, are some fine works of art, especially the pierced stirrups, an embossed breast-plate, and a portion of horse armour to fit on the tail—"a croupier." In the second half of the bay, on the wall, are some stilettos and small daggers, the blades of which can be provided with poisonous matter. These are called "misericordes." A sword, with a small firelock and barrel at the hilt, said to have belonged to a Doge of Venice, is exhibited at the centre of this bay. The semicircular arrangement of rapiers, radiating from a shield in repoussée work, is striking, and forms a good trophy with the elaborately inlaid pistols, dags, &c., in the case below. Of these latter, one with a hideous dragon's head at the muzzle (from which originated Dragoon Guards), and the "Demi Haque," with wheel lock, are perhaps the most curious. The mounted figures, two of which are in jousting suits, and, in fact, represented as tilting or jousting at a tournament, may be taken as the three representatives of armour belonging to the Elizabethan time. The "vambraces," or shoulder guards, on the two tilting figures are very curious, and appear to be of an exaggerated size. The "vambrace" of the second figure —a Bavarian suit of armour—is particularly remarkable, on account of the coarse ribs, which are the leading feature of the Bavarian arms, as well as being an additional protective property to the piece of armour. The "manefere" on the first horse is of open work steel, and a band of twelve bells is hung round the neck of the horse. The third figure is in an extremely finely-engraved and gilt suit. The bit of the horse is or-

namented with brass bosses; and the stirrups and muzzle, similar in work to some shown on the wall, are of pierced-work, which is an effective mode of decorating the trappings. Leaving this bay, the most important artistic works, namely, the "Ferrara" suit and another one, both of the finest repoussée work, demand the greatest attention. The shape of these pieces of armour, admitting as they do, with great advantage, of a fine display of the highest decorative art, is, however, very poor when compared with the earlier breast-plates, helmets, &c., particularly those already mentioned of the reign of Henry VIII. Some authorities attribute the work of the gilt suit to Benvenuto Cellini, but for this statement there is no authentic reference known. To furnish an accurate description of these fine works would occupy the space of several columns in this *Journal* if dealt with from an æsthetic and critical point of view. It will be sufficient perhaps at present to call the special attention of visitors to these suits of armour, not omitting the damascened steel baton at the foot of the case. The damascened work consists of ten columns of minute figures, and the baton itself is hollow, to contain the muster-roll of an army. It originally belonged to the famous Duke of Alva.

(To be continued.)

Fine Arts.

FINE ART EXHIBITION AT BORDEAUX.—The exhibition of works of fine art is announced, by the Bordeaux Society of the Friends of Art, to take place in March next, and the committee adds to the announcement of the coming exhibition an acount of the results of the past. Last year, it appears, the Emperor presented the society with the sum of a thousand francs; the Conseil Général of the Department of the Gironde voted 1,500 francs; and the municipal council of Bordeaux, 3,000 francs, besides placing the gallery at the disposition of the society. The society has organised seventeen exhibitions, and counts more than seven hundred members, who have subscribed in all one thousand and ten shares of one pound each. The last exhibition, open from 21st March to the 23rd May, 1868, contained 636 works, of which 187 were purchased for the sum of 89,321 francs, or nearly £3,573. The total cost of the purchases made since the establishment of the society, that is to say at the seventeen exhibitions, has amounted to 821,900 francs, or £36,876. Thirty-four of these purchased works, costing nearly four thousand pounds, have been placed in the museum of Bordeaux.

ELECTROTYPE ORNAMENTS.—The galleries of Greek and Roman sculpture in the Louvre have been largely increased and embellished of late, and amongst the ornaments introduced are a number of bas-reliefs, round bosses, and allegorical figures, covered with a coating of metal, the work of M. Cossinus. The effect of these electrotype bronzes is extremely rich, while the cost is trivial compared with real bronzes.

Manufactures.

PROPOSED DUTCH INTERNATIONAL EXHIBITION.—On Tuesday, the 29th December, a deputation waited upon the Lord Mayor at the Mansion-house, for the purpose of bringing before him the subject of an international exhibition of domestic economy, which is proposed to be held at Utrecht in August and September next. The deputation consisted of Baron Mackay, from the Hague; M. Everwyn, Chargé d'Affaires, and Mr. J. W. May, Consul-General of the Netherlands; the Rev. William Rogers, rector of Bishopsgate, and Mr. Le Neve Foster, Secretary of the Society of Arts. The Netherlands Society of Manufactures and Industry have undertaken the conduct of the matter; and the Netherlands government has requested its chargé d'affaires in this country to use his best endeavours to further the objects in view. The principal aim of the exhibition is to bring to the knowledge of working men such articles of household use, furniture, dress, food, work, and instruction of different countries, as at low prices combine usefulness with solidity, so that they may be enabled by judicious economy to improve their condition. Articles of luxury as well as of elegance strictly so called will be excluded, and in this point of view it is thought the exhibition will derive great advantage from the countenance and assistance of co-operative association in the collection of reports, statutes, and regulations of different societies for promoting the well-being of the working classes. A central committee has been organised at the Hague, having for its president Baron Mackay, who is now in London, promoting the objects of the proposed exhibition. With that view he has attended a meeting at Manchester, presided over by the Mayor, and also at Glasgow, at which the Provost was present, and much success has thus resulted in making known the objects which it is hoped to attain in the cause of the working classes. The deputation at the Mansion-house was introduced to the Lord Mayor by Mr. Goschen, the President of the Poor-Law Board. The Lord Mayor evinced much interest in the views of the deputation, and promised to co-operate in giving them effect, for which purpose a committee is now in course of formation in the City.

BLEACHING OF WOOD-PULP FOR PAPER.—M. Orioli, a French chemist, says, in the *Revue hebdomadaire de Chimie*, that the chloride of lime, if the dose is the least in excess, has a tendency to give a yellow tinge to the pulp; that all energetic acids, without exception, tend to give a reddish colour to the paper when exposed for a long time to the effects of the sun or of moisture, and that the least trace of iron is sufficient in a very short time to blacken the pulp. He says he has succeeded in avoiding all these inconveniences by the use of the following mixture:—For a hundred-weight of wood-pulp, he employs 400 grammes (four-fifths of a pound) of oxalic acid, which has the double advantage of bleaching the colouring matter already oxidised, and of neutralising the alkaline principles which favour such oxidation; he adds to the oxalic acid one pound, or a little more, of sulphate of alumina, entirely deprived of iron. The principal agent in this mode of bleaching is the oxalic acid, the power of which over vegetable colouring matters is well-known; the alum has no bleaching power of its own, but it forms with the colouring matter of the wood an almost colourless lake, which has the effect of increasing the brilliancy of the pulp.

SILK MANUFACTURE AT ZURICH.—In 1855 the number of silk looms at work in the canton of Zurich was 25,290, employing 32,862 weavers. During the most prosperous years of the silk trade, from 1858 to 1860, the number was 28,000, employing 37,000 weavers. Since then there has been a great falling off in this manufacture, and in 1867, though more active than the preceding years, the total number of silk looms was only 18,276, employing 26,883 weavers; and, although this trade is gradually improving, it will be many years before it regains its former prosperity. The total value of silk stuffs manufactured during 1855 was 8,291,406 francs, and in 1867 it amounted to 7,279,810 francs.

Colonies.

CULTIVATION OF COTTON IN NEW SOUTH WALES.—In Queensland two thousand acres of land are now planted with sugar-cane, and the culture of cotton has been there much more successful than in New South Wales; it has not, however, been proved that the climate or soil of New South Wales is unsuited for the production of cotton, but hitherto the attempts to establish cotton-growing in

that colony have been almost exclusively made by a large company, whereas in Queensland numerous small farmers have, in spite of repeated disappointments, successfully cultivated cotton, relying chiefly on the members of their own families for the requisite labour.

Sugar Manufacture in New South Wales.—The erection of numerous mills for the manufacture of sugar, on the northern rivers of this colony, will give an immense impetus to the cultivation of the cane. Considerable areas of land are being cropped with the varieties best suited for cultivation, and in twelve months hence a large and profitable return may reasonably be expected. Attention is also being paid to the cultivation of arrowroot and rice, branches of agriculture that may prove equally remunerative.

Victorian Railways.—There continues to be a considerable improvement in the revenue of the Government railways. The total revenue from 1st of January, 1868, to 15th October was £437,207, or a weekly average of £10,712 against £9,976 during corresponding period of last year. The weekly average returns of the Melbourne and Hobson's Bay Company's lines since the beginning of last year has been £2,328, against £2,145 in 1867.

Notes.

Scholastic Registration Association.—The annual general meeting of this association will be held at the offices, 42, Queen-square, Bloomsbury, on Wednesday, the 6th of January, 1869, at 7 o'clock, p.m., to receive the reports of the secretary, of the treasurer, and of the auditors; to elect ten members of the committee, and two auditors; and to take into consideration various notices of motion. A conference of teachers, and other persons interested in middle-class education, for the purpose of discussing the recommendations made by the Schools Inquiry Commissioners in their recent report, will be held (by permission of the Council) at the house of the Society of Arts, on the following day, Thursday, the 7th January, at 12 o'clock. The chair will be taken by the Rev. W. Haig-Brown, LL.D., Head Master of the Charter House School, and President of the Council of the College of Preceptors. The object of this conference is to give teachers generally an opportunity of expressing and comparing their views upon the general principles of the scheme recommended by the commissioners, which, although mainly directed to the organisation of middle-class education, will, if carried into operation, materially affect the position and interests of teachers of every grade throughout the country. The following is the programme of subjects for discussion:—1. Qualifications of schoolmasters; 2. Grades of schools; 3. Privileges to be granted to registered private schools; what can be done to improve private schools, and make the profession attractive to men of ability; 4. Inspection and examination of schools by a central authority; the relative advantages of inspection and examination; 5. Constitution of the proposed council of examinations; 6. Education of girls.

Proposed Tunnel under the Mersey.—On Monday, the 21st December, an influential meeting was held at the Cotton Sales-room, Liverpool, Mr. Patterson, President of the Chamber of Commerce, in the chair, when Sir Charles Fox explained the project of making a railway tunnel under the Mersey, connecting Liverpool and Birkenhead and the Lancashire and Cheshire Railway termini. Sir Charles said that the engineering difficulties were comparatively slight as compared with those encountered in making the Thames Tunnel. The preliminary expenses for the "heading," which could be afterwards used for gas pipes, telegraph wires, &c., would not exceed £20,000, and the cost of the entire tunnel, with two lines and rolling stock, would not exceed £460,000. Sir Charles alluded to the metropolitan underground railways, and pointed out that at present twenty millions of people crossed the Mersey annually. Resolutions in favour of the scheme were unanimously agreed to.

Correspondence.

Artificial Refrigeration.—Sir,—I very much regret having failed to make myself intelligible to Mr. Flower when, in reading my paper on this subject, I expressed the opinion that Mr. King was entitled to the merit of having been the first to put to the test of practical trial the idea of applying ice-making machinery to direct refrigeration, and that it is to his enterprise that those interested in the subject of artificial refrigeration are indebted for the working out of this problem. I regret this more especially since I laid particular stress on that fact as being, in my judgment, one of the most important steps yet made in reference to the use of such ice-making machines as are yet known. I was at the time fully aware that Messrs. Flower had for the past three years employed in their brewery an ice-making machine, and that they had in 1867 taken out a patent for the use of brine or other dense solution, artificially reduced to a low temperature, for cooling brewers' wort and beer, and it was after full consideration of those facts that I expressed the opinion above referred to, which Mr. Flower now calls in question. I am not now aware of any circumstance which would require me to alter that opinion. By reference to my paper it will be seen that I pointed out the advantage to be gained in certain cases by direct refrigeration as compared with ice making, and I specially illustrated the nature and cause of this advantage in the case of the ether machine, which, so far as I am able to judge, is the only machine yet before the public that is suitable for artificial refrigeration. In fact, the advantage of direct refrigeration over ice making does not obtain in the case of the air machine, with which it is as easy to make ice as to cool water, except in so far as there may be a waste by communication of heat to the brine from the surrounding atmosphere, and by the transfer of the ice from the moulds in which it is formed. But the waste from either or both sources is, or need be, only very trifling. In the ether machine, however, the case is very different, for in working at the low temperature necessary for making ice the density of the ether vapour produced in the refrigerator is only about one-third to one-half what it is when the machine is used for cooling water to say 40° F. Consequently, in making ice, each stroke of the pump transfers from the refrigerator to the condenser only one-third or one-half as much ether as at the higher temperature, and for the same rate of working the machine the vaporization of ether—which is the immediate cause of the refrigeration—is only one-third or one-half as great as at the higher temperature. This is the explanation of the difference between the results obtained by Mr. King in ice making and in direct refrigeration, and a very important difference it is, inasmuch as the efficacy of the machine is thereby increased nearly threefold. I am not aware that this fact had ever been pointed out, or that this method of working was ever suggested before its adoption by Mr. King, and so far as I am acquainted with what Messrs. Flower have done in the use of ice making machines, I do not know that they have ascertained this fact, nor do I find anything to lead me to suppose that it was involved in any method they have adopted. Therefore, I still think that the credit of having first recognised or demonstrated this fact is due to Mr. King, quite irrespective of anything he may have seen at Stratford, and of anything contained in the specification of Messrs. Flower's patent. With regard to the assumed infringement of Messrs. Flower's patent, which your correspondent asserts Mr. King "must be" practising, I will only quote for his information the following passages:—First from the specification of a patent dated the 31st May, 1867, the complete specification of which was

filed on the 30th November, 1867:—"The liquid thus cooled may be used to freeze water, *to refrigerate brewers' wort, ales,* wines, and for other refrigerating purposes. Any other liquid of a non-congealable character may be passed through the tube, but a solution of chloride of calcium is preferable, owing to its cheapness and the low temperature to which it may be reduced without congealing; air may also be cooled by passing through the tubes." Secondly, from the specification of a patent dated 25th April, 1862, the complete specification of which was filed on the 24th October, 1862:—"A continued current of a saturated solution of common salt in water, spirit, air, or other convenient fluid, not liable to freeze at the lowest temperature used, which current *may be employed to cool any other substance* at a greater or less distance from the machine." And, lastly, from the specification of a patent dated 15th October, 1860. the complete specification of which was filed on the 15th April, 1861:—"Besides the formation of ice, the cold thus produced may be applied, as already stated, to the cooling of air, liquids, and other fluids, or even solids; to preserve food or aliments which are deteriorated by a high temperature; to facilitate the crystallization and precipitation of various salts and chemical products, &c., &c. . . . . *also to moderate the heat produced by fermentation, especially of wine, beer, and vinegar.*" I need now only state that Messrs. Flower's patent for the application of cooled brine or other dense solution to cooling brewers' wort and beer is dated the 8th of November, 1867, and that the complete specification was filed on the 7th February, 1868. —I am, &c., Benj. H. Paul.

Artificial Refrigeration.—Sir,—Mr. Flower, in his letter published in your *Journal* of the 25th instant, makes the very serious charge against me of deliberately infringing his patent. On reference to the specification of his patent, I find he says, "I use brine or water in which has been dissolved sugar, or saline, or other soluble matters;" and again, "The essence of my invention consists in cooling brewers' worts by the use of brine or other dense solution." I do nothing of the sort. In Dr. Paul's able paper my process was accurately described; there is, therefore, no need for me to repeat it here. If Mr. Flower had, before writing the letter, witnessed my application of Messrs. Siebe's ice-making machine, he would have satisfied himself that his invention is not infringed; and I do not hesitate to say, that by adopting my plan in preference to his own he would save at least fifty per cent. in cost of working.—I am, &c., T. King, Engineer.

Truman's Brewery, Spitalfields, N.E., Dec. 30th, 1868.

Electric Organ.—Sir,—Mr. Barber's inventions for the transmission of sound from the organ by electricity, induce me to call attention to acoustic means of transmission of musical sound, experiments on which have been long since suspended. I published some notes in the *Mechanics' Magazine* about 1836 or 1837.—I am, &c., Hyde Clarke.

32, St. George's-square, S.W., Dec. 30, 1868.

MEETINGS FOR THE ENSUING WEEK.

Mon......Entomological, 7.
British Architects, 8.
Medical, 8.
Victoria Inst., 8.
Tues ...Royal Inst., 3. Prof. Odling, "On Carbon." (Juvenile Lectures.)
Syro-Egyptian, 7½. Rev. John Mills, "Warren's Excavations in Jerusalem."
Pathological, 8. Annual Meeting.
Anthropological, 8.
Wed ...Pharmaceutical, 8.
R. Society of Literature, 4½.
Obstetrical, 8. Annual Meeting.
Scholastic Registration Assoc., 7. Annual General Meeting.
Thur ...Royal, 8½.
Royal Society Club, 6.
Royal Inst., 3. Prof. Odling, "On Carbon." (Juvenile Lectures.)
Society of Fine Arts, 8. Mr. T. H. Wright, "On the Music of the Harp," with Illustrations.
Fri ......Astronomical, 8.
Sat ......R. Botanic, 3¾.
Royal Inst., 3. Prof. Odling, "On Carbon." (Juvenile Lectures.)

Patents.

From Commissioners of Patents' Journal, December 25.

Grants of Provisional Protection.

Bedsteads and leg rests for railway carriages—3810—C. A. B. Pocock.
Boilers—3438—W. R. Griffiths.
Boilers—3832—S. C. Lister.
Bottle stoppers—3780—Z. Poirier.
Bridges, &c., framings and joints applicable to—3788—H. L. D. Marsden.
Copper, &c., precipitating from solutions by iron—3822—W. A. Verel and J. Cameron.
Fabrics, manufacturing looped—3820—W. Cotton & E. Attenborough.
Felt-manufacturing apparatus—3808—W. Bywater.
Fibrous materials, spinning, &c.—3794—S. W. Smith.
Files, renewing worn-out—3836—J. Thorniley and G. B. Wing.
Flour, treating—3846—J. C. Walker.
Helmets, hats, &c—3802—J. H. Brown.
Iron and steel—3842—G. H. Benson and W. G. Valentin.
Letter boxes, apparatus applicable to—3782—C. E. Brooman.
Letter boxes, &c.—3662—P. Ellis.
Locks—3796—C. E. Brooman.
Mattresses and camp beds—3814—J. Frazer and W. Naar.
Mattresses, spring—3776—A. Woods.
Metals, inlaying—3828—A. M. Clark.
Miners' lamps 3826—L. Desens.
Motive-power—3792—H. E. Newton.
Ores, &c., treating—3786—A. Prince.
Paper sheets, &c., separating, &c.—3318—W. Collins, jun.
Pigments, black or brown 2578—P. R. and W. Hodge.
Pistons 3848—J. Quick, jun., and J. Sampson.
Rocks, boring—3824—J. B. Everard.
Sewage, treating—3457—C. Jones.
Signalling apparatus—3816—T. Wilson.
Smoke, &c, consuming—3784—F. Erskine.
Steam cultivators—3830—T. Aveling.
Tailors' measures—3778—C. Ellison and E. Parkinson.
Tea-kettles—3798—J. Thomas.
Tubes or cylinders—3844—T. Inglis and T. English.
Valves—3806—A. Baumann.
Ventilating apparatus—3812—M. Lockhart.
Wool, &c., preparing—3834—S. C. Lister.

Inventions with Complete Specifications Filed.

Chimes, machinery of—3860—D. Imhof.
Cotton, &c., machinery for spinning—3861—T. Spencer.

From Commissioners of Patents' Journal, December 29.

Patents Sealed.

2093. J. Blomfield.	2158. G. Morton.
2094. M. Bebro, O. Hopwood, and W. Elam.	2170. W. Tasker, jun.
2099. R. Ward.	2175. T. J. Mayall.
2100. T. Ward and W. S. Black.	2183. A. M. Clark.
2105. C. F. Crailsheim.	2197. R. Mackie.
2109. H. H. Henson.	2206. A. Munro & W. B. Adamson.
2111. J. D. Pinfold.	2217. J. Cope and J. Bradbrook.
2113. E. J. Scott.	2219. W. Shaw.
2121. A. F. Robertson.	2220. W. B. Farwell.
2124. C. Roussel.	2314. P. Pearson.
2129. J. B. Brown.	2492. F. Le Roy.
2134. A. Fryer.	2542. W. Shaen.
2135. A. Albini.	3165. W. R. Lake.
2144. A. Fryer.	3365. W. R. Lake.

Patents on which the Stamp Duty of £50 has been Paid.

3321. S. Chatwood.	84. R. A. Brooman.
5. T. Prideaux.	85. R. A. Brooman.
16. A. and W. Young.	115. N. W. Wheeler.
3323. E. Clifton.	3338. J. Fisher.
3334. G. and D. Hurn.	3342. J. Rea.
3350. N. W. Wheeler.	3345. J. Young, jun.
3351. N. W. Wheeler.	3369. A. Barclay.
3353. J. Bates and E. and E. W. Brookes.	3336. E., J. O., and J. Lones, J. and T. Brettell, and C. Vernon.
3358. R. A. Brooman.	

Patents on which the Stamp Duty of £100 has been Paid.

3217. J. Rosindell.	3214. J. H. Johnson.
56. H. Bessemer.	3235. R. Needham.
3258. J. B. Payne.	3249. E. Lord.